

WAR PRODUCTION BOARD
NATIONAL EMERGENCY SPECIFICATIONS
FOR THE
DESIGN, FABRICATION AND ERECTION
OF STRUCTURAL STEEL FOR BUILDINGS

DATED SEPTEMBER 10, 1942

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OF STRUCTURAL STEEL FOR BUILDINGS

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CHAPTER IX—WAR PRODUCTION BOARD
SUBCHAPTER A—GENERAL PROVISIONS
PART 905 — SPECIFICATIONS
DIRECTIVE NO. 8

NATIONAL EMERGENCY SPECIFICATIONS
FOR THE
DESIGN, FABRICATION AND ERECTION
OF STRUCTURAL STEEL FOR BUILDINGS

Pursuant to the authority vested in me by Executive Orders Na. 9024 of January 16, 1942, Na. 9040 of January 24, 1942, and Na. 9125 of April 7, 1942, and pursuant to the policy stated in the Joint Directive of the War Production Board and the War and Navy Departments dated May 20, 1942, and the Army and Navy Munitions Board "List of Prohibited Items for Construction Work," dated April 1, 1942, as revised June 29, 1942, the following policy is prescribed (1) for the War Production Board and for the Army, Navy, Maritime Commission, Reconstruction Finance Corporation, National Housing Agency, and (2) for all other Departments and Agencies in respect to war construction and the financing of war construction.

*§ 905.1 National Emergency Specifications for the Design,
Fabrication and Erection of Structural Steel for Buildings.*

Adoption of Specifications

(a) National Emergency Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings issued by the War Production Board September 10, 1942, shall apply to and shall govern the designing, fabrication and erection of structural steel for all buildings which are constructed by, or the construction of which is financed by, or the construction of which must be approved by any of such Departments or Agencies, the contracts for which are placed after a date sixty days after the issuance of this Directive. Such Departments or Agencies, however, are empowered to put this Directive into immediate effect wherever possible.

(b) With respect to any such contracts already placed by any of said Departments or Agencies or entered into prior to a date sixty days after the issuance of this Directive, the Department or Agency concerned shall review the contract promptly and shall change to said Emergency Specifications unless such change will result in any substantial delay in the war effort.

(c) The Agency undertaking or approving the construction shall obtain from the person in responsible charge of the design of each such building a certificate to the effect that said specifications have been complied with, and that the building has been designed to secure the greatest savings of steel practical through continuity in design and through welded fabrication. In cases where Forms PD-200 and PD-200A must be filed with the War Production Board in order to obtain authorization to begin construction of such building, such certificate shall be filed with said forms.

(d) Authority to depart from the provisions of this Directive may, upon specific request, be granted by the Director General for Operations of the War Production Board, or by such person or persons as he may designate for this purpose.

Issued this 10th day of September, 1942.

(Signed) Donald M. Nelson
Chairman, War Production Board

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The following is a list of the
 names of the persons who
 have been elected to the
 office of the President of the
 United States since the year
 1789.

Year	Name
1789	George Washington
1797	John Adams
1801	Thomas Jefferson
1809	James Madison
1817	James Monroe
1823	James Monroe
1829	Andrew Jackson
1837	Martin Van Buren
1841	William Henry Harrison
1845	James K. Polk
1849	Zachary Taylor
1853	Franklin Pierce
1857	James Buchanan
1861	Abraham Lincoln
1865	Andrew Johnson
1869	Ulysses S. Grant
1873	Rutherford B. Hayes
1877	Ulysses S. Grant
1881	James A. Garfield
1885	James A. Garfield
1889	Benjamin Harrison
1893	Grover Cleveland
1897	William McKinley
1901	William McKinley
1905	Theodore Roosevelt
1909	William Howard Taft
1913	Woodrow Wilson
1917	Woodrow Wilson
1921	Warren G. Harding
1923	Calvin Coolidge
1925	Calvin Coolidge
1929	Herbert Hoover
1933	Franklin D. Roosevelt
1937	Franklin D. Roosevelt
1941	Franklin D. Roosevelt
1945	Dwight D. Eisenhower
1949	Dwight D. Eisenhower
1953	Dwight D. Eisenhower
1957	John F. Kennedy
1961	John F. Kennedy
1965	Lyndon B. Johnson
1969	Richard M. Nixon
1973	Richard M. Nixon
1977	Gerald R. Ford
1981	Ronald Reagan
1985	Ronald Reagan
1989	George H. W. Bush
1993	Bill Clinton
1997	Bill Clinton
2001	George W. Bush
2005	George W. Bush
2009	Barack Obama
2013	Barack Obama
2017	Donald Trump

**WAR PRODUCTION BOARD
NATIONAL EMERGENCY SPECIFICATIONS
FOR THE
DESIGN, FABRICATION AND ERECTION
OF STRUCTURAL STEEL FOR BUILDINGS**

DATED SEPTEMBER 10, 1942

PART I. GENERAL

SECTION 1. SCOPE

This specification defines the practice to be followed during the emergency in the design, fabrication, and erection of structural steel for buildings.

As used throughout this specification, the term "structural steel" refers exclusively to those materials which are assigned to Class A in the American Institute of Steel Construction Code of Standard Practice for Steel Structures other than Bridges and nothing herein contained shall be interpreted as a recommended practice for any material not specifically assigned to Class A in such Code.

This specification applies to riveted, bolted, and welded construction. See Appendix A for permissible types of construction.

This specification does not apply to steel joists, members formed of flat rolled steel, light-gage steel construction, skylights, marquees (except frame), fire escapes, or other similar miscellaneous light steel construction.

SECTION 2. CODE

In the execution of contracts entered into under this specification, the Code of Standard Practice for Steel Structures other than Bridges of the American Institute of Steel Construction shall apply unless otherwise specified or required.

SECTION 3. PLANS, DRAWINGS, AND DEFINITIONS

(a) Plans

The plans (design drawings) shall show a complete design with sizes, sections, and the relative locations of the various members. Floor levels, column centers, and offsets shall be dimensioned. Plans shall be drawn to a scale large enough to convey the information adequately.

Plans for welded construction shall indicate the type or types of construction (as defined in Appendix A) to be employed and shall be supplemented by such data as to the assumed loads, and the shears, moments, and axial forces to be resisted by all members and their connections, as may be required for the proper preparation of the shop drawings.

(b) Shop Drawings

Shop drawings, giving complete information necessary for the fabrication of the component parts of the structure, including the location, type, size and extent of all

welds, shall be prepared in advance of the actual fabrication. They shall clearly distinguish between shop and field welds, bolts and rivets.

Shop drawings shall be made in conformity with the best modern practice and with due regard to speed and economy in fabrication and erection.

(c) Definitions for Welding

All terms herein relating to welds, welding and gas cutting shall be construed in accordance with the standard "Definitions of Welding Terms and Master Chart of Welding Processes" of the American Welding Society, as amended to date.

(d) Notations for Welding

Note shall be made on the plans and on the shop drawings of those joints or groups of joints in which it is especially important that the welding sequence and technique of welding be carefully controlled to minimize locked-up stresses and distortion.

Weld lengths called for on the plans and on the shop drawings shall be the net effective lengths.

(e) Symbols for Welding

Welding symbols used on plans and shop drawings shall be the American Welding Society Symbols; or other adequate welding symbols may be used provided a complete explanation thereof is shown on the plans or drawings.

PART II. MATERIAL

SECTION 4. MATERIAL

(a) Structural Steel

Structural steel shall conform to the Standard Specifications of the American Society for Testing Materials for Structural Steel for Bridges and Buildings, Serial Designation A-7, as amended to date.

(b) Rivet Steel

Rivet steel shall conform to the Standard Specifications of the American Society for Testing Materials for Structural Rivet Steel, Serial Designation A-141, as amended to date.

(c) Other Metals

Alloy steels, cast steel, cast iron and other metals shall conform to the applicable Specifications of the American Society for Testing Materials, as amended to date.

(d) Stock Material

Stock material shall be of a quality equal to that called for by paragraph (a). Mill test reports shall constitute sufficient record as to the material taken from stock.

Unidentified stock material, if free from surface imperfections, may be used for short sections of minor importance, or for small unimportant details, where the precise physical properties of the material would not affect the strength of the structure.

(e) Filler Metal

All arc-welding electrodes shall conform to the requirements of the A.W.S. Specifications for Iron and Steel Arc-Welding Electrodes, latest edition. Electrodes shall be of Classification Numbers E6010, E6011, E6012, E6013, E6020 or E6030 and shall be suitable for the positions and other conditions of intended use.

With each container of electrodes the manufacturer shall furnish instructions giving recommended voltage and amperage (and polarity if direct current) for all uses and welding positions for which the electrode is suitable.

All gas-welding rods shall conform to the requirements of the A.W.S. Specifications for Iron and Steel Gas-Welding Rods, latest edition. Rods shall be of Classification Numbers GA60 or GA65 and shall be suitable for the conditions of intended use.

PART III. LOADS AND STRESSES**SECTION 5. LOADS AND FORCES**

(a) Steel structures shall be designed to sustain the following loads and forces:

1. Dead Load
2. Live Load
3. Impact
4. Wind and other Lateral and Longitudinal Forces
5. Erection Loads
6. Other Forces

(b) Dead Load

The dead load shall consist of the weight of the steel-work and all material fastened thereto or permanently supported thereby.

(c) Live Load

The live load and snow load, if any, shall be that stipulated by the Code under which the structure is being designed or that required by the conditions involved. In general, the live loads should not be less than those recommended by the Building Code Committee of the Department of Commerce, November, 1924, under the caption "Minimum Live Loads for Use in the Design of Buildings," except that for floors used for storage purposes the minimum live load per square foot shall be the actual weight for the material stored, as posted, but not less than 100 pounds per square foot.

(d) Posting of Live Loads

In view of the increases in allowable stresses herein provided, all buildings erected under this Emergency Specification shall be conspicuously posted to indicate design live loads and warn specifically against overloading floors, crane girders, monorail beams, and roofs beyond the stated loadings. Such posting shall be maintained during the life of the structure.

(e) Impact

For structures carrying live loads which induce impact or vibration, the assumed live load shall be increased sufficiently to provide for same.

If not otherwise specified, the increase shall be:

For supports of elevators	100 percent
For supports of traveling cranes (girders and columns).....	25 percent
For supports of light machinery, shaft or motor-driven, not less than	20 percent
For supports of reciprocating machinery or power-driven units, not less than	50 percent

(f) Crane Runway Forces

The lateral force on crane runways to provide for the effect of crane trolleys shall, if not otherwise specified, be 20 percent of the lifted load plus the weight of the crane trolley but exclusive of other parts of the crane, applied at the top of rail, one-half on each side of runway, and considered as acting in either direction normal to the runway rail.

The longitudinal force shall, if not otherwise specified, be taken as 10 per cent of the wheel loads of the crane, applied at top of rail.

(g) Wind

Proper provision shall be made for stresses caused by wind both during erection and after completion of the building. The wind pressure is dependent upon the conditions of exposure and geographical location of the structure. The allowable stresses specified in Sections 7(d) and 8 are based upon the steel frame being designed to carry a wind pressure of not less than twenty (20) pounds per square foot on the vertical projection of exposed surfaces during erection and fifteen (15) pounds per square foot on the vertical projection of the finished structure.

(h) Erection

Proper provision shall be made for temporary stresses caused by erection.

(i) Other Forces

Structures in localities subject to earthquakes, hurricanes, and other extraordinary conditions shall be designed with due regard for such conditions.

SECTION 6. REVERSAL OF STRESS

Members subject to loads (other than wind loads) producing alternating tensile and compressive stresses shall be proportioned as follows:

To the net total compressive stress and to the net total tensile stress add 50 percent of the smaller of the two, and proportion the member to resist each of these increased stresses.

Connections shall be proportioned to resist the larger of the two increased stresses; and in welded construction if the reversal may be expected to occur over 100,000 times in the life of the building, the unit stresses in the connecting welds shall not exceed 75 per cent of those specified in Section 10(a).

SECTION 7. COMBINED STRESSES**(a) Axial and Bending**

Members subject to both axial and bending stresses shall be so proportioned that the quantity

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \quad \text{shall not exceed unity, in which}$$

F_a =axial unit stress that would be permitted by this specification if axial stress only existed,

F_b =bending unit stress that would be permitted by this specification if bending stress only existed,

f_a =axial unit stress (actual)=axial stress divided by area of member,

f_b =bending unit stress (actual)=bending moment divided by section modulus of member.

(b) Welds

In the case of welds subject to stress from both shearing and bending forces, the maximum unit stress, resulting from the combination, shall for fillet welds not exceed that allowed for shear in Section 10(a), and shall for butt welds not exceed the tension or compression value (whichever is the smaller) allowed in Section 10(a).

(c) Rivets

Rivets subject to shearing and tensile forces shall be so proportioned that the combined unit stress will not exceed the allowable unit stress for rivets in tension only.

(d) Wind and Other Forces

Members subject to stresses produced by a combination of wind or temperature, or both, with other loads may be proportioned for unit stresses 30 percent greater than those specified in Section 10 but not greater than 27000 pounds per square inch, except that this paragraph shall not apply to the stress on extreme fibers of pins specified in Section 10(a) under the subheading BENDING nor to the stresses specified in Section 10(a) under the subheading BEARING, provided the section thus required is not less than that required for the combination of dead load, live load, and impact.

SECTION 8. MEMBERS CARRYING WIND ONLY

Members subject only to stresses produced by wind forces may be proportioned for unit stresses 30 percent greater than those specified in Section 10 but not greater than 27000 pounds per square inch, except that this paragraph shall not apply to the stress on extreme fibers of pins specified in Section 10(a) under the subheading BENDING nor to the stresses specified in Section 10(a) under the subheading BEARING.

SECTION 9. EFFECTIVE SPAN LENGTH**(a) Simple Spans**

Beams, girders, and trusses, as in TYPE 2 construction (as defined in Appendix A) shall ordinarily be designed on the basis of simple spans whose effective length is equal to the distance between centers of gravity of the members to which they deliver their end reactions.

(b) End Restraint

When designed on the assumption of end restraint, full or partial, based on continuous or cantilever action, beams, girders and trusses, as well as the sections of the members to which they connect, shall be designed to carry the shears and moments so introduced, in addition to all other forces, without exceeding at any point the unit stresses prescribed in Section 10.

PART IV. UNIT STRESSES

SECTION 10. ALLOWABLE UNIT STRESSES

All parts of the structure shall be so proportioned that the unit stress in pounds per square inch shall not exceed the following values, except as provided elsewhere in this specification. Lower unit stresses than those specified in this section shall not be used in the calculation for the design of the structure.

(a) Structural Steel, Weld Metal, Rivets and Bolts

TENSION

Structural Steel, net section.....	24 000
Butt welds, section through throat.....	20 000
Rivets, on area based on nominal diameter.....	15 000
Bolts and other threaded parts, on nominal area at root of thread....	13 000

COMPRESSION

Columns, gross section

For axially loaded columns with values of l/r not greater than 120 $17\,000 - 0.485 \frac{l^2}{r^2}$

For axially loaded columns with values of l/r greater than

$$120. \dots\dots\dots \frac{18\,000}{1 + \frac{l^2}{18\,000 r^2}}$$

in which l is the unbraced length of the column, and r is the corresponding radius of gyration of the section, both in inches.

Plate Girder Stiffeners, gross section.....	20 000
Webbs of Rolled Sections at toe of fillet [Crippling, see Section 22(j)]	24 000
Butt welds, section through throat (crushing).....	24 000

BENDING

Tension on extreme fibers of rolled sections, plate girders, and built-up members [See Section 22(a)]..... 24 000

Compression on extreme fibers of rolled sections, plate girders, and built-up members, for values of l/b not greater than 40.....

$$\frac{25\,500}{1 + \frac{l^2}{1\,400 b^2}}$$

with a maximum of 24 000, in which l is the laterally unsupported length of the member, and b is the width of the compression flange, both in inches.

Stress on extreme fibers of pins.....	30 000
Fiber stresses in butt welds, due to bending, shall not exceed the values prescribed for tension and compression, respectively.	

SHEARING

Rivets	17 000
Pins, and turned bolts in reamed or drilled holes.....	17 000
Unfinished bolts	12 000
Webs of beams and plate girders, gross section.....	14 000

Weld Metal

on section through throat of fillet weld, or on faying surface area of filled plug or slot weld..	15 000
(Stress in a fillet weld shall be considered as shear on the throat, for any direction of the applied stress. Neither filled nor fillet-welded plug or slot welds shall be assigned any values in resistance to stresses other than shear.)	

on section through throat of butt weld.....	14 000
---	--------

BEARING

	Double Shear	Single Shear
Rivets	40 000	32 000
Turned bolts in reamed or drilled holes.....	40 000	32 000
Unfinished bolts.....	25 000	20 000
Pins	32 000	
Contact Area		
Milled Stiffeners and other Milled Surfaces.....	30 000	
Fitted Stiffeners	27 000	
Expansion rollers and rockers (pounds per linear inch)....	600d	
in which d is diameter of roller or rocker in inches.		

(b) Cast Steel

Compression and Bearing same as for Structural Steel.

Other Unit Stresses, 75 percent of those for Structural Steel.

(c) Effective Areas of Weld Metal

The effective area of butt and fillet welds shall be considered as the effective length of weld times the effective throat thickness.

The effective shearing area of filled plug and slot welds shall be considered as the nominal cross-sectional area of the hole or slot, in the plane of the faying surface.

The effective area of fillet welded plug or slot welds shall be computed as above specified for fillet welds, using for the effective length, the length of center line of the weld through the center of the plane through the throat. However, in the case of overlapping fillets, the effective area shall not exceed the nominal cross-sectional area of the hole or slot, in the plane of the faying surface.

The effective length of a fillet weld shall be the overall length of full-size fillet, including returns.

The effective length of a butt weld shall be the width of the part joined, when the ends of the weld are made with extension bars as specified in Section 29(j). A transverse skewed butt weld shall not be assumed in computations to be longer than the width of the joint or piece perpendicular to the direction of stress.

The effective throat thickness of an equal leg 45-degree fillet weld shall be considered as 0.707 times the nominal size of the weld. The effective throat thickness of fillet welds other than the foregoing shall be 0.707 times the leg length of the largest isosceles right triangle that can be inscribed in the fillet.

The effective throat thickness of a complete-penetration butt weld (i.e., a butt weld conforming to the requirements of Section 29(j), 3d paragraph) shall be the thickness of the thinner part joined.

The effective throat thickness of an incomplete-penetration butt weld (i.e., a butt weld not conforming to the requirements of Section 29(j), 3d paragraph, but conforming to same Section, 4th paragraph) shall, for design purposes, be considered as 75 percent of the thickness of the thinner part joined.

The effective throat thickness of a fillet reinforced butt-welded T-joint shall be considered as the throat thickness of the butt weld plus the throat thickness of the fillet weld or welds.

PART V. DESIGN

SECTION 11. SLENDERNESS RATIO

(a) The ratio of unbraced length to least radius of gyration l/r for compression members and for tension members other than rods shall not exceed:

For main compression members.....	120
For bracing and other secondary members in compression.....	200
For tension members, other than rods.....	300

(b) Staying members and connections between which l is measured shall be proportioned as compression members according to the stress in the member for which the stay provides the support. Such stays shall be anchored to braced points.

SECTION 12. HORIZONTAL FORCES

Provision shall be made for carrying all lateral and longitudinal forces to the foundation.

SECTION 13. DEFLECTION

Deflection shall be considered in all construction. Computed deflections shall not exceed those suitable for the type and use of the structure. Beams and trusses may be cambered (see Section 26).

SECTION 14. MINIMUM THICKNESS OF MATERIAL

(a) Flanges

The thickness of outstanding legs of angles and of projecting elements not supported against buckling on the profiles of girder, beam and tee sections, shall be not less than 1/10 of their projection when subjected to compression, and not less than

1/16 of their projection when subjected only to tension. Fillets shall not be considered as contributing support.

(b) Compression Members

In compression members consisting of segments connected by cover plates or lacing, or segments connected by webs, the thickness of the webs of the segments shall be not less than 1/32 of the unsupported distance between the nearest lines of welding, or riveting, or the roots of the flanges in case of rolled sections. The thickness of cover plates or webs connecting such segments shall be not less than 1/40 of the unsupported distance between the nearest lines of the connecting welds or rivets, or the roots of their flanges in case of rolled sections.

(c) Understressed Compression Members

In the case of members or parts in compression, if the maximum unit stress is less than that allowable under this specification, the denominators of the fractions specified in Section 14(a) and (b) may be multiplied by the factor $\sqrt{\frac{f_1}{f}}$ in which f_1 = the allowable unit stress and f = the actual unit stress in the member.

SECTION 15. GROSS AND NET SECTIONS

(a) Definitions

The gross section of a member at any point shall be determined by summing the products of the thickness and the gross width of each element as measured normal to the axis of the member. The net section shall be determined by substituting for the gross width the net width computed in accordance with paragraphs (c) to (h) of this section.

(b) Application

Unless otherwise specified, tension members shall be designed on the basis of net section. Columns shall be designed on the basis of gross section. Beams and girders shall be designed in accordance with Section 22(a).

In determining the net section across plug or slot welds the weld metal shall not be considered as adding to the net area.

(c) Single Angles in Tension

Sections shall be made symmetrical wherever practicable. The effective area of single angles in tension shall be assumed as the net area of the connected leg plus 50 percent of the area of the unconnected leg. Single angles connected by lug angles shall be considered as connected by one leg. Single angles connected by lug angles shall not be used in welded construction.

(d) Net Width

In the case of a chain of holes extending across a part in any diagonal or zigzag line, the net width of the part shall be obtained by deducting from the gross width the sum of the diameters of all the holes in the chain, and adding, for each gage space in the chain, the quantity

$$\frac{s^2}{4g}, \text{ where}$$

s = longitudinal spacing (pitch) in inches of any two successive holes,

g = transverse spacing (gage) in inches of the same two holes.

The critical net section of the part is obtained from that chain which gives the least net width.

(e) Angles

For angles, the gross width shall be the sum of the widths of the legs less the thickness. The gage for holes in opposite legs shall be the sum of the gages from back of angle less the thickness.

(f) Splice Members

For splice members, the thickness considered shall be only that part of the thickness of the member which has been developed by rivets beyond the section considered.

(g) Size of Holes

In computing net area the diameter of a rivet hole shall be taken as $\frac{1}{8}$ inch greater than the nominal diameter of the rivet.

(h) Pin Holes

In pin connected tension members, the net section across the pin hole, transverse to the axis of the member, shall be not less than 140 percent, and the net section beyond the pin hole, parallel with the axis of the member, not less than 100 percent of the net section of the body of the member.

In all pin-connected riveted members the net width across the pin hole, transverse to the axis of the member, shall preferably not exceed 8 times the thickness of the member at the pin.

SECTION 16. EXPANSION

Provision for expansion shall be made in all structures either by consideration of stresses caused by changes in temperature [see Section 7(d)] or by the use of expansion joints.

SECTION 17. CONNECTIONS

(a) Minimum Connections

Connections carrying calculated stresses, except for lacing, sag bars, and girts, shall be connected for not less than 10,000 pounds, and if riveted or bolted, shall have no fewer than two rivets or two bolts.

(b) Eccentric Connections

Members meeting at a point shall have their gravity axes meet at a point if practicable; if not, provision shall be made for bending stresses due to eccentricity, if any, in the disposition and section of base metal parts and in the location of the connecting welds or rivets. Pins may be so placed as to counteract the effect of bending due to dead load.

(c) Unrestrained Members in Welded Construction

Except as otherwise indicated by the designer, all connections of beams, girders or trusses shall be designed as flexible, and may ordinarily be proportioned for the reaction shears only, subject to the requirements of Paragraph (b).

Flexible beam connections (see TYPE 2, Appendix A) shall permit the ends of the beam to rotate sufficiently to accommodate its deflection by providing for a horizontal displacement of the top flange determined as follows:

$e = .009d$ if the beam is designed for full uniform load and for deflection not exceeding $1/360$ th of the span,

or, $e = \frac{f \times L}{3\,625\,000}$ if the beam is designed for full uniform load producing the unit stress f at mid span;

where e = the horizontal displacement between the top and bottom of the beam at its end, in inches,

f = the flexural unit stress in the beam at mid span, p.s.i.,

d = the depth of the beam, in inches,

L = the span of the beam, in feet.

(d) Restrained Members

When beams, girders or trusses are subject both to reaction shear and end moment, due to the restraint specified in Section 9(b), their connections shall be specially designed to carry both shear and moment without exceeding the unit stresses prescribed in Section 10.

(e) Fillers

In welded construction when a filler is used between two parts connected in shear, there shall be sufficient welding to transfer the shearing stress from one part to the filler and from the filler to the other part. Fillers of less than $\frac{1}{4}$ -inch thickness shall not be used to transfer stress, but shall be trimmed flush with the welded edges of the stress-carrying element and the sizes of the weld along the edges shall be increased over the required sizes by an amount equal to the thickness of the filler.

When rivets or bolts carry computed stress through fillers, the fillers shall be extended beyond the connected member and the extension secured by enough rivets or bolts to distribute the total stress in the member uniformly over the combined sections of the member and filler. Fillers under plate-girder stiffeners at end bearings or points of concentrated loads shall be secured by sufficient rivets to prevent excessive bending and bearing stresses.

(f) Welded Connections of Members in Trusses

Welded connections at ends of tension or compression members in trusses shall either develop the full effective strength of the member or they shall develop the strength required by the total stresses, calculated on the assumption that all live and impact loads are increased 15 percent, but in no case shall such strength developed be less than 50 percent of the effective strength of the member connected.

(g) Milled Joints in Compression Members

Where compression members are in full-milled bearing on base plates, and where full-milled tier-building columns are spliced, there shall be sufficient welding or riveting to hold all parts securely in place. Where other compression members are spliced by full-milled bearing, the splice material shall be arranged to hold all parts in line and shall be proportioned for not less than 50 percent of the computed stress. All the

foregoing joints shall be proportioned to resist any tension that would be developed by specified wind forces acting in conjunction with 75 percent of the calculated dead-load stress and no live load, if this condition will produce more tension than with full dead load and live load applied.

(h) Combinations of Welds

If two or more of the general types of weld (butt, fillet, plug, slot) are combined in a single joint, the effective capacity of each shall be separately computed with reference to the axis of the group, in order to determine the allowable capacity of the combination.

(i) Rivets and Bolts in Combination with Welds

In new welded construction rivets or bolts in combination with welds shall not be considered as sharing the stress, and welds shall be provided to carry the entire stress for which the connection is designed.

In making alterations to structures, existing rivets may be utilized for carrying stresses resulting from existing dead loads, and welding shall be provided to carry all additional stress.

SECTION 18. WELDS

(a) Types of Welds

Butt, fillet, plug or slot welds, or a combination of these types, may be used in making joints and joining component parts.

(b) Qualification of Weld Details

The details of all joints (including for butt welds the groove form, root face, root spacing, etc., etc.) to be employed under this specification without qualification shall comply with all of the requirements for pre-qualified joints of the American Welding Society Code for Arc and Gas Welding in Building Construction. No joint form not included in the foregoing shall be employed until it shall have been qualified to the satisfaction of the Engineer in accordance with the American Welding Society "Standard Qualification Procedure."

(c) Minimum Size of Fillet Welds

The relation between weld size and the maximum thickness of material on which various sizes of fillet welds may be used shall preferably be in accordance with the following table:

<i>Size of Fillet Weld</i>	<i>Maximum Thickness of Part</i>
<i>Inches</i>	<i>Inches</i>
$\frac{3}{16}$	$\frac{1}{2}$
$\frac{1}{4}$	$\frac{3}{4}$
$\frac{5}{16}$	$1\frac{1}{4}$
$\frac{3}{8}$	2
$\frac{1}{2}$	6
$\frac{5}{8}$	Over 6

(d) Maximum Effective Size of Fillet Welds

The maximum size of a fillet weld that may be assumed in the design of a con-

nection shall be such that the stresses in the adjacent base material do not exceed the values allowed in Section 10(a).

The maximum nominal size of fillet weld applied to a nominally square edge of a plate or section shall be $\frac{1}{16}$ inch less than the nominal thickness of the edge, and the nominal size of fillet weld used along the toe of an angle or the rounded edge of a flange shall not exceed three-fourths the nominal thickness of the angle leg or three-fourths the nominal edge thickness of the flange; except that when required by the design conditions and specially designated on the drawings, fillet welds equal in size to the edge of a plate or rolled section may be used, provided that the weld is built out in such a manner as to insure full throat thickness, full fusion area, and no injury to the base metal that will reduce its thickness adjacent to the weld.

(e) Length of Fillet Welds

The minimum effective length of a strength fillet weld shall be not less than four times the nominal size, or else the size of the weld shall be considered not to exceed one-fourth of its effective length.

The effective length of any segment of intermittent fillet welding shall be not less than four times the weld size with a minimum of $1\frac{1}{2}$ inches.

If longitudinal fillet welds are used alone in end connections, the length of each fillet weld shall be not less than the perpendicular distance between them.

(f) End Returns of Fillet Welds

Side or end fillet welds terminating at ends or sides, respectively, of parts or members shall, wherever practicable, be returned continuously around the corners for a distance not less than twice the nominal size of the weld. This provision shall apply to side and top fillet welds connecting brackets, beam seats and similar connections, at the tension side of such connections, on the plane about which bending moments are computed. End returns shall be indicated on the design and detail drawings.

(g) Plug and Slot Welds

Plug or slot welds may be used in plates not more than one inch thick, where subjected principally to shearing stresses or where needed to prevent buckling of lapped parts.

The diameter of the holes for plug welds and the width of slot welds shall be not less than the thickness of the part containing the hole or slot, plus $\frac{5}{16}$ inch, rounded to the next greater odd sixteenth. The diameter of filled plug welds and the width of filled slot welds shall not be greater than $2\frac{1}{4}$ times the thickness of the weld metal.

The maximum length of slot welds shall not exceed 10 times the thickness of the part containing the slot.

SECTION 19. SPACING OF WELDS

(a) Longitudinal Fillet Welds

The transverse spacing of longitudinal fillet welds used in end connections shall not exceed 8 inches, unless end transverse welds or intermediate plug or slot welds are used.

(b) Intermittent Fillet Welds

Intermittent fillet welds may be used to transfer calculated stress across a joint

or faying surfaces when the strength required is less than that developed by a continuous fillet weld of the smallest practical size. The clear spacing between the effective lengths of such segments at the edges of plates and the unsupported edges of rolled shapes carrying calculated stress shall not exceed the following number of times the thickness of the thinner part joined:

16 times for compression

24 times for tension

and shall in no case be more than 12 inches. The effective length of longitudinal fillet welds at the ends of built-up members shall be not less than the width of the component part joined.

(c) Lap Joints

The minimum width of laps, on lap joints, shall be five times the thickness of the thinner part joined and not less than 1 inch. Lap joints joining plates or bars subjected to axial stress shall be fillet-welded along the edge of both lapped parts except where deflection of the lapped parts is sufficiently restrained to prevent opening of the joint under maximum loading.

(d) Plug and Slot Welds

The clear distance from the edge of a slot to the adjacent edge of the slotted part and the clear distance between adjacent slots, measured in a direction perpendicular to that of the main stress, shall be not less than five times the thickness of the slotted part nor less than twice the width of the slot.

(e) Stitch Welds

If two or more plates or rolled shapes are used to build up a member, sufficient stitch welding (of the fillet, plug or slot type) to make the parts act in unison shall be provided as follows except where transfer of calculated stress between the parts joined requires closer spacing:

1. For plates, the longitudinal clear spacing between stitch welds shall not exceed the provisions of paragraph (b) of this section and the transverse spacing shall not exceed 24 times the thickness of the thinner plate joined.
2. For members composed of two or more rolled shapes, in contact one with another, the longitudinal spacing of stitch welds shall not exceed 24 inches or the limits prescribed in (3).
3. For members composed of rolled shapes, separated one from the other by a gusset plate, the component parts shall be stitched together at intervals such that the critical ratio l/r , for each component, between stitching, shall not exceed three-fourths the critical ratio for the whole member.

SECTION 20. RIVETS AND BOLTS

(a) Diameter

In proportioning and spacing rivets, the nominal diameter of the undriven rivet shall be used.

(b) Effective Bearing Area

The effective bearing area of pins, bolts, and rivets shall be the diameter multi-

plied by the length in bearing; except, that for countersunk rivets, half the depth of the countersink shall be deducted.

(c) Double and Single Shear Bearing

Only that portion of a rivet or bolt shall be considered in double-shear bearing, which lies between two portions which are stressed in the opposite direction. The remainder of the rivet or bolt shall be considered in single-shear bearing.

(d) Long Grips

Rivets carrying calculated stress, and whose grip exceeds five diameters, shall have their number increased 1 percent for each additional $\frac{1}{16}$ inch in the rivet grip. Special care shall be used in heating and driving such rivets.

(e) Use of Rivets, Turned Bolts, and Unfinished Bolts

Field connections may be made with unfinished bolts, except as follows:

Column splices in all tier structures 200 feet or more in height.

Column splices in tier structures 100 to 200 feet in height, if the least horizontal dimension is less than 40 percent of the height.

Column splices in tier structures less than 100 feet in height, if the least horizontal dimension is less than 25 percent of the height.

Connections of all beams and girders to columns, and of any other beams and girders on which the bracing of columns is dependent, in structures over 125 feet in height.

Roof-truss splices and connections of trusses to columns, column splices, column bracing, and crane supports in all structures carrying cranes of over 5-ton capacity.

Connections for supports of running machinery, or of other live loads which produce impact or reversal.

Any other connections stipulated on the design plans.

For the purpose of this specification, the height of a tier structure shall be taken as the vertical distance from the curb level to the highest point of the roof beams, in the case of flat roofs, or to the mean height of the gable, in the case of roofs having a rise of more than one to a $4\frac{1}{2}$ run. Where the curb level has not been established, or where the structure does not adjoin a street, the mean level of the adjoining land shall be used instead of curb level. Penthouses may be excluded in computing the height of a structure.

Turned bolts in reamed or drilled holes, as specified in Section 29(e), may be used in shop or field work. The finished shank shall be long enough to provide full bearing, and washers shall be used under the nuts to give full grip when the nuts are turned tight.

SECTION 21. RIVET AND BOLT SPACING

(a) Minimum Pitch

The preferable minimum distance between centers of holes shall be not less than $4\frac{1}{2}$ inches for $1\frac{1}{4}$ inch rivets, 4 inches for $1\frac{3}{8}$ inch rivets, $3\frac{1}{2}$ inches for 1 inch rivets, 3 inches for $\frac{7}{8}$ inch rivets, $2\frac{1}{2}$ inches for $\frac{3}{4}$ inch rivets, 2 inches for $\frac{5}{8}$ inch rivets, and $1\frac{3}{4}$ inches for $\frac{1}{2}$ inch rivets, but in no case shall it be less than three times the diameter of the rivet. The spacing for bolts shall be the same as that for rivets of the same nominal diameter.

(b) Maximum Pitch Compression Members

The maximum pitch in the line of stress of compression members composed of plates and shapes shall not exceed 16 times the thickness of the thinnest outside plate or shape, nor 20 times the thinnest enclosed plate or shape with a maximum of 12 inches, and at right angles to the direction of stress the distance between lines of rivets shall not exceed 30 times the thickness of the thinnest plate or shape. For angles in built sections with two gage lines, with rivets staggered, the maximum pitch in the line of stress in each gage line shall not exceed 24 times the thickness of the thinnest plate with a maximum of 18 inches.

(c) End Pitch Compression Members

The pitch of rivets at the ends of built compression members shall not exceed four diameters of the rivets for a length equal to $1\frac{1}{2}$ times the maximum width of the member.

(d) Two-Angle Members

In tension members composed of two angles, a pitch of 3' 6" will be allowed, and in compression members, 2' 0", but the ratio l/r for each angle between rivets shall be not more than $\frac{3}{4}$ of that for the whole member.

(e) Minimum Edge Distance

The minimum distance from the center of any punched rivet hole to any edge shall be that given in Table I.

TABLE I

<i>Rivet Diameter, Inches</i>	<i>Minimum Edge Distance (Inches) for Punched Holes</i>		
	<i>In Shearcd Edge</i>	<i>In Rolled Edge of Plates and Sections with Parallel Flanges</i>	<i>In Rolled Edge of Sections with Sloping Flanges</i>
$\frac{1}{2}$	1	$\frac{7}{8}$	$\frac{3}{4}$ *
$\frac{5}{8}$	$1\frac{1}{8}$	1	$\frac{7}{8}$ *
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	1 *
$\frac{7}{8}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{8}$ *
1	$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$ *
$1\frac{1}{8}$	2	$1\frac{3}{4}$	$1\frac{1}{2}$ *
$1\frac{1}{4}$	$2\frac{1}{4}$	2	$1\frac{3}{4}$ *

* May be decreased $\frac{1}{8}$ inch when holes are near end of beam

(f) Minimum Edge Distance in Line of Stress

The distance from the center of any rivet under computed stress, and that end or other boundary of the connected member toward which the pressure of the rivet is directed, shall be not less than the shearing area of the rivet shank (single or double shear respectively) divided by the plate thickness.

This end distance may however be decreased in such proportion as the stress per rivet is less than that permitted under Section 10(a); and the requirement may be disregarded in case the rivet in question is one of three or more in a line parallel to the direction of stress.

(g) Maximum Edge Distance

The maximum distance from the center of any rivet to the near edge shall be 12 times the thickness of the plate but shall not exceed 6 inches.

SECTION 22. PLATE GIRDERS AND ROLLED BEAMS**(a) Proportioning**

Welded and riveted plate girders, cover-plated beams, and rolled beams shall in general be proportioned by the moment of inertia of the gross section. No deduction shall be made for standard shop or field rivet holes in either flange; except that in special cases where the reduction of the area of either flange by such rivet holes, calculated in accordance with the provisions of Section 15, exceeds 10 per cent of the gross flange area, the excess shall be deducted. If such members contain other holes, as for bolts, pins, countersunk rivets, or plug or slot welds, the full deduction for such holes shall be made. The deductions thus applicable to either flange shall be made also for the opposite flange if the corresponding holes are there present.

(b) Web

Plate girder webs shall have a thickness of not less than $1/170$ of the unsupported distance between flanges.

(c) Flanges

Each flange of welded plate girders shall in general consist of a single plate rather than two or more plates superimposed. The single plate may comprise a series of shorter plates, laid end to end and butt welded at their junctions. The minimum thickness of flange plates shall conform to the requirements of Section 14(a).

Cover plates of riveted plate girders, when required, shall be equal in thickness or shall diminish in thickness from the flange angles outward. No plate shall be thicker than the flange angles. Unstiffened cover plates shall not extend more than 6 inches nor more than 10 times the thickness of the thinnest plate beyond the outer row of rivets connecting them to the angles. The total cross-sectional area of cover plates shall not exceed 70 per cent of the total flange area.

(d) Flange Welds

The welds connecting the flanges to the web, or cover plates to flanges, shall be proportioned to resist the maximum horizontal shear, at the plane of welding, resulting from the bending moment on the girder. Additionally, welds connecting flanges to the web shall be proportioned to transmit any loads applied directly to the flange.

(e) Rivets

Rivets connecting the flanges to the web shall be proportioned to resist the horizontal shear due to bending as well as any loads applied directly to the flange.

(f) Stiffeners

Bearing stiffeners shall be placed in pairs on the webs of plate girders at unframed ends and at points of concentrated loads. Such stiffeners shall have a close bearing against the loaded flanges, and shall extend as closely as possible to the edge of the flange plates or flange angles. They shall be designed as columns subject to

the provisions of Section 10(a), assuming the column section to comprise the pair of stiffeners and a centrally located strip of the web equal to not more than 25 times its thickness at interior stiffeners or a strip equal to not more than 12 times its thickness when the stiffeners are located at the end of the web. The column length shall be taken as not less than $\frac{3}{4}$ of the length of the stiffeners in computing the ratio, l/r . Only that portion of the stiffener outside of the flange-to-web welds or the angle fillet shall be considered effective in bearing. Angle bearing stiffeners shall not be crimped.

If h/t is equal to or greater than 70, intermediate stiffeners shall be required at all points where h/t exceeds $\frac{8000}{\sqrt{v}}$ in which

h = the clear depth between flanges, in inches,

t = the thickness of the web, in inches,

v = the greatest unit shear in the panel, in pounds per square inch under any condition of complete or partial loading.

The clear distance between intermediate stiffeners, when stiffeners are required by the foregoing, shall not exceed 84 inches or that given by the formula,

$$d = \frac{270000 t}{v} \sqrt{\frac{vt}{h}} \text{ where}$$

d = the clear distance between stiffeners, in inches.

Intermediate stiffeners may be applied in pairs, one on each side of the web, or if preferred may alternate on opposite sides of the web.

Intermediate angle stiffeners may be crimped over the flange angles.

Intermediate bar stiffeners employed to stay the web plate against buckling, and not for the transfer of concentrated loads from flange to web, shall be of a section not less than that required by the formula,

$$I_s = 0.0000016 h^4, \text{ in which}$$

h = total depth of web.

I_s = moment of inertia of the stiffeners or stiffener (figured with a common axis at the centerline of web for stiffeners in pairs and with the axis at the interface between stiffener and web for single stiffeners).

Welds or rivets connecting stiffeners to the girder web shall be proportioned to transmit the stress due to any concentrated loads. If intermittent fillet welds are used they shall conform to the provisions of Section 19(b). If the girder is subjected to substantial fluctuations in loading, the stiffeners shall not be welded to the tension flange, except at points where the maximum flange stress is less than half the allowable.

(g) Splices

Webs shall be spliced with a complete penetration butt weld, or if riveted, shall be proportioned to transmit the full shearing and bending stresses in the web at the point of splice.

If the flanges are spliced, the splices shall either develop the full effective strength of the material or they shall develop the strength required by the total stresses, calculated on the assumption that all live and impact loads are increased 15 per cent, but in no case shall the strength developed be less than 50 per cent of the effective strength of the material spliced.

(h) Lateral Forces

The flanges of plate girders supporting cranes or other moving loads shall be proportioned to resist any lateral forces produced by such loads.

(j) Web Crippling of Beams

Rolled beams shall be so proportioned that the compression stress at the web toe of the fillets, resulting from concentrated loads not supported by bearing stiffeners, shall not exceed the value of 24,000 pounds per square inch allowed in Section 10(a). The governing formulas shall be,

$$\text{For interior loads } \frac{R}{t(N + 2k)} = \text{not over } 24\,000$$

$$\text{For end reactions } \frac{R}{t(N + k)} = \text{not over } 24\,000$$

where

R = concentrated interior load or end reactions, in pounds,

t = thickness of web, in inches,

N = length of bearing, in inches,

k = distance from outer face of flange to web toe of fillet, in inches.

SECTION 23. SEPARATORS

Where two or more rolled beams or channels are used to form a girder, they shall be connected together at intervals of not more than 5 feet. Through-bolts and separators may be used provided that in beams having a depth of 12 inches or more, not less than 2 bolts shall be used with each separator. When concentrated loads are carried from one beam to the other, or distributed between the beams, diaphragms shall be used, designed with sufficient stiffness to distribute the load. Where beams are exposed, they shall be filled with concrete or spaced sufficiently far apart to permit cleaning and painting.

SECTION 24. TIE PLATES**(a) Compression Members**

The open sides of compression members built up from plates or shapes shall be provided with lacing having tie plates at each end, and at intermediate points if the lacing is interrupted. Tie plates shall be as near the ends as practicable. In main members carrying calculated stress the end tie plates shall have a length of not less than the distance between the lines of welds or rivets connecting them to the segments of the member, and intermediate ones of not less than one-half of this distance. The thickness of tie plates shall be not less than one-fiftieth of the distance between the lines of welds or rivets connecting them to the segments of the members, and the welding on each such line shall aggregate not less than one-third the length of tie plate, or if riveted, the rivet pitch shall be not more than four diameters and the tie plates connected to each segment by at least three rivets.

(b) Tension Members

Tie plates shall be used to secure the parts of tension members built-up from plates or shapes. They shall have a length not less than two-thirds of the length specified for tie plates in compression members. The thickness shall be not less than

one-fiftieth of the distance between the lines of welds or rivets connecting them to the segments of the member, and the welding or riveting shall be not less than that prescribed in (a) above.

SECTION 25. LACING

(a) Spacing

Lacing bars of compression members shall be so spaced that the ratio l/r of the flange included between their connections shall be not over $\frac{3}{4}$ of that of the member as a whole.

(b) Proportioning

Lacing members shall be proportioned to resist a shearing stress normal to the axis of the member equal to two per cent of the total compressive stress in the member. In determining the section required the compression formula shall be used, l being taken as the unsupported length of the bar between the welds or outside rivets connecting it to the segment for single lacing and 70 percent of that distance for double lacing. Lacing members shall be arranged in single system for welded construction and the ratio l/r shall not exceed 100. For riveted construction, the ratio l/r shall not exceed 140 for single lacing nor 200 for double lacing.

(c) Inclination

The inclination of lacing bars to the axis of the members shall preferably be not less than 45 degrees for double lacing and 60 degrees for single lacing. When the distance between connections to the flanges is more than 15 inches, the lacing shall be double and riveted, bolted, or welded at the intersection if bars are used; the lacing shall be made of angles if bars are not used.

SECTION 26. CAMBER

(a) Shown on Drawings

Cambering, if any, of trusses, beams or girders shall be called for on the drawings.

(b) Trusses and Girders

Trusses of 80 feet or greater span shall generally be cambered for approximately the dead load deflection. Crane girders of 75 feet or greater span shall generally be cambered for approximately the dead and half live load deflection.

(c) Beams

Specified camber for rolled beams over 15 inches in depth, shall be only that offered as cold cambering at the mill.

(d) Camber for Other Trades

If camber is required in order to bring a loaded member into proper relation with the work of other trades, as for the attachment of runs of sash, the requirement shall be set forth on the design and detail drawings.

(e) Erection

Required camber of trusses shall be shown on the erection diagrams. If camber

involves the erection of any member under a straining force, this shall be noted on the erection diagrams.

(f) Initial Stress

The total initial stress in any adjustable member shall be assumed as not less than 5,000 pounds.

SECTION 27. COLUMN BASES

(a) Loads

Proper provision shall be made to transfer the column loads, and moments, if any, to the footings and foundations.

(b) Alignment

Column bases shall be set level and to correct elevation with full bearing on the masonry.

(c) Finishing

Column bases shall be finished to accord with the following requirements:

1. Rolled steel bearing plates, 2 inches or less in thickness, may be used without planing, provided a satisfactory contact bearing is obtained; rolled steel bearing plates, over 2 inches, but 4 inches or less in thickness, may be straightened by pressing; or, if presses are not available, by planing on all bearing surfaces, to obtain a satisfactory contact bearing; rolled steel bearing plates, over 4 inches in thickness, shall be planed on all bearing surfaces (except as noted under 3).
2. Column bases other than rolled steel bearing plates shall be planed on all bearing surfaces (except as noted under 3).
3. The bottom surfaces of bearing plates and column bases which rest on masonry foundations and are grouted to insure full bearing contact need not be planed.

SECTION 28. ANCHOR BOLTS

Anchor bolts shall be designed to provide resistance to all conditions of tension and shear at the bases of columns, including the tensile components of any bending moments which may result from fixation or partial fixation of columns.

PART VI. FABRICATION

SECTION 29. WORKMANSHIP

(a) General

All workmanship shall be equal to the best practice in modern structural shops.

(b) Straightening

All material shall be clean and straight. If straightening or flattening is necessary, it shall be done by a process and in a manner that will not injure the material. Sharp kinks or bends shall be cause for rejection.

(c) Temperatures

No welding shall be done when the temperature of the base metal is lower than 0° F. At temperatures between 32° F. and 0° F., the surface of all areas within three inches of the point where a weld is to be started, shall be heated to a temperature at least warm to the hand before welding is started.

When welds are being made in parts thicker than 1½ inches, the temperature of the base material adjacent to the welding shall be at least 70° F.

(d) Preparation of Material for Welding

Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material, except that mill scale which withstands vigorous wire brushing, may remain. A light film of linseed oil may be disregarded. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done with a mechanically guided torch.

(e) Holes

Holes for rivets or unfinished bolts shall be ⅛ inch larger than the nominal diameter of the rivet or bolt. If the thickness of the material is not greater than the nominal diameter of the rivet or bolt plus ⅛ inch, the holes may be punched. If the thickness of the material is greater than the nominal diameter of the rivet or bolt plus ⅛ inch, the holes shall be either drilled from the solid, or sub-punched and reamed. The die for all sub-punched holes, and the drill for all sub-drilled holes, shall be ⅛ inch smaller than the nominal diameter of the rivet or bolt.

Holes for turned bolts or pins shall be ⅓₀ inch larger $\pm$.005 in. than the external diameter of the bolt or pin. If the bolts are to be inserted in the shop, the holes may be either drilled from the solid, or sub-punched and reamed. If the bolts are to be inserted in the field, the holes shall be sub-punched in the shop and reamed in the field. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

Drifting to enlarge unfair holes shall not be permitted. Holes that must be enlarged to admit the rivets shall be reamed. Poor matching of holes shall be cause for rejection.

(f) Planing

Planing or finishing of sheared plates or shapes will not be required unless specifically called for on the drawings, or included in a stipulated edge preparation for welding.

(g) Assembling for Welding

Parts to be fillet welded shall be brought in as close contact as practicable, and in no event shall be separated more than ⅜ inch. If the separation is ⅜ inch or greater, the size of the fillet welds shall be increased by the amount of the separation. The separation between faying surfaces of lap joints shall not exceed ⅜ inch. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting.

Abutting parts to be butt welded shall be carefully aligned. Misalignments greater than $\frac{1}{8}$ inch shall be corrected and, in making the correction, the parts shall not be drawn into a sharper slope than two degrees ($\frac{7}{16}$ inch in 12 inches).

The work shall be positioned for flat welding whenever practicable.

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member.

(h) Assembling for Riveting

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting done during assembling shall not distort the metal or enlarge the holes.

(j) Welding

Welds shall be made only by operators who have been previously qualified by tests, as prescribed in the American Welding Society "Standard Qualification Procedure," to perform the type of work required, except that this provision need not apply to tack welds not later incorporated into finished welds carrying calculated stress.

The technique of welding employed, the appearance and quality of welds made, and the methods used in correcting defective work shall conform to the American Welding Society Code for Arc and Gas Welding in Building Construction, Section 4—Workmanship.

All complete-penetration butt welds, except when produced with the aid of backing material or welded from both sides in square-edge material not more than $\frac{5}{16}$ inch thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged or chipped out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire intended cross section. Butt welds made with the use of a backing of the same material as the base shall have the weld metal thoroughly fused with the backing material. Backing strips may be removed by means of gas cutting, after welding is completed, provided no injury is done to the base and weld metal and the weld surface is left flush or slightly convex with full throat thickness.

Incomplete-penetration butt welds shall be thoroughly fused to the base metal for at least seven-eighths of the thickness of the parts joined, or in the case of welds made from one side only, to within one-sixteenth of an inch of the surface away from which the weld is made, whichever requirement will produce the deeper weld.

To insure soundness, the ends of butt welds that carry stresses approaching the maximum allowable working stress shall be extended past the edges of the parts joined, by means of short extension bars providing a similar joint preparation and having a width not less than the thickness of the thicker part joined. If extension

bars are removed upon completion of the weld, the ends of the weld shall be left smooth and flush with the edges of the abutting parts.

(k) Riveting

All rivets are to be power-driven hot. Rivets driven by pneumatically or electrically operated hammers are considered power-driven. Standard rivet heads shall be of approximately hemispherical shape and of uniform size throughout the work for the same size rivet, full, neatly finished, and concentric with the holes. Rivets, after driving, shall be tight, completely filling the holes, and with heads in full contact with the surface. Rivets shall be heated uniformly to a temperature not exceeding 1950° F.; they shall not be driven after their temperature is below 1000° F.

Loose, burned, or otherwise defective rivets shall be replaced.

(l) Peening

Where required, multiple-layer welds may be peened with light blows from a power hammer, using an elongated round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling, flaking or cold working of weld and base metal from over-peening.

(m) Finishing

Compression joints depending upon contact bearing shall have the bearing surfaces truly machined to a common plane after the members are completed.

(n) Lacing Bars

The ends of lacing bars shall be neat and free from burrs.

(o) Tolerances

Finished members shall be true to line and free from twists, bends, and open joints.

Compression members may have a lateral variation not greater than $\frac{1}{1000}$ of the axial length between points which are to be laterally supported.

A variation of $\frac{1}{32}$ inch is permissible in the overall length of members with both ends milled.

Members without milled ends which are to be framed to other steel parts of the structure may have a variation from the detailed length not greater than $\frac{1}{16}$ inch for members 30 feet or less in length, and not greater than $\frac{1}{8}$ inch for members over 30 feet in length.

(p) Castings

All steel castings shall be annealed.

(q) Gas Cutting

The use of a cutting torch is permissible if the metal being cut is not carrying stresses during the operation. To determine the effective width of members so cut, $\frac{1}{8}$ inch shall be deducted from each gas cut edge. The radius or re-entrant gas cut fillets shall be as large as practicable, but never less than 1 inch. Material may be prepared for welding by gas cutting as defined in Section 29 (d).

SECTION 30. SHOP PAINTING

(a) Shop Coat

After inspection and approval and before leaving the shop, all steel work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, spatter, slag or flux deposit, oil, dirt and other foreign matter. Except where encased in concrete, and excepting edges to be field welded, all steel work shall be given one coat of approved metal protection, applied thoroughly and evenly and well worked into the joints and other open spaces. All paint shall be applied to dry surfaces.

(b) Inaccessible Parts

Parts inaccessible after assembly shall be given two coats of shop paint, preferably of different colors.

(c) Contact Surfaces

Contact surfaces shall be cleaned, by effective means, before assembly, but not painted.

(d) Finished Surfaces

Machine finished surfaces shall be protected against corrosion by a suitable coating.

(e) Surfaces to be Field Welded

Surfaces which are to be welded after erection shall preferably not receive a shop coat of paint.

PART VII. ERECTION

SECTION 31. ERECTION

(a) Bracing

The frame of all steel skeleton buildings shall be carried up true and plumb, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including equipment, and the operation of same. Such bracing shall be left in place as long as may be required for safety.

(b) Adequacy of Temporary Connections

As erection progresses, the work shall be securely welded or bolted up to take care of all dead load, wind and erection stresses.

(c) Erection Stresses

Wherever piles of material, erection equipment or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from the same.

(d) Alignment

No welding or riveting shall be done until as much of the structure as will be stiffened by the welding or riveting has been properly aligned.

(e) Field Welding

All field assembly and welding shall be executed in accordance with the requirements of Section 29 excepting such as manifestly apply to shop conditions only.

Any shop paint on surfaces adjacent to joints to be field welded shall be thoroughly removed to expose clean steel for a distance of at least 2 inches on either side of the joint.

(f) Riveting

Rivets driven in the field shall be heated and driven with the same care as those driven in the shop.

(g) Turned Bolts

Holes for turned bolts to be inserted in the field shall be reamed in the field as specified in Section 29(e).

(h) Field Painting

All field welds and field rivets and bolts, also all serious abrasions to the shop coat, shall be spot painted with the material used for the shop coat, or an equivalent, and all mud and other firmly attached and objectionable foreign materials shall be removed, before general field painting.

Responsibility for this touch-up and cleaning, as well as for general field painting, shall be allocated in accordance with accepted local practices and this allocation shall be set forth explicitly in the contract.

PART VIII. INSPECTION

SECTION 32. INSPECTION

(a) General

Material and workmanship at all times shall be subject to the inspection of experienced engineers representing the purchaser.

(b) Cooperation

All inspection as far as possible shall be made at the place of manufacture, and the Contractor or Manufacturer shall cooperate with the Inspector, permitting access for inspection to all places where work is being done.

(c) Rejections

Material or workmanship not conforming to the provisions of this specification may be rejected at any time defects are found during the progress of the work.

(d) Inspection of Welding

The inspection of welding shall be performed in accordance with the provisions of Section 5 of the American Welding Society Code for Arc and Gas Welding in Building Construction.

APPENDIX A

TYPES OF CONSTRUCTION

Three basic types of design and design assumption are permissible, under the respective conditions stated hereinafter, and each will govern in a specific manner the sizes of members and the types and strength of their connections.

TYPE 1, hereinafter designated as "rigid-frame" (continuous, restrained frame), assumes that the end connections of beams, or girders and all other members in frame have sufficient rigidity to hold virtually unchanged the original angles between such members and the members to which they connect.

TYPE 2, hereinafter designated as "conventional" or "simple" framing (unrestrained, free-ended), assumes that the ends of beams and girders are connected for shear only, and are free to rotate under load.

TYPE 3, hereinafter designated as "semi-rigid framing" (partially restrained), assumes that the connections of beams and girders possess a dependable and known moment capacity intermediate in degree between the complete rigidity of TYPE 1 and the complete flexibility of TYPE 2.

All welded connections shall be consistent in their design with the assumptions as to type of construction, as called for on the design drawings.

TYPE 1 construction is unconditionally permitted under this specification. It is a necessary condition of this type that the calculated stresses and resulting strains in all members and their connections occur within the elastic range, and that the stresses do not exceed those allowed in Section 10 of this specification.

TYPE 2 construction is permitted under this specification, subject to the stipulations of the following paragraph wherever applicable. Beam-to-column connections with seats for the reactions and with top clip angles for lateral support only, are classed under TYPE 2.

In tier buildings, designed in general as TYPE 2 construction, in that the beam-to-column connections other than wind connections are flexible, the distribution of the wind moments, as between the several joints of the frame, may be made by a recognized empirical method provided that either:

1. The wind connections, designed to resist the assumed wind moments, are adequate to resist the moments induced by the gravity loading and the wind loading, at the increased unit stresses permitted therefor, or

2. The wind connections, designed to resist the assumed wind moments, are so designed that larger moments, induced by the gravity loading under the actual condition of restraint, will be relieved by deformation of the connection material without overstress in the connections.

TYPE 3 (semi-rigid) construction will be permitted only upon evidence that the connections to be used are capable of resisting definite moments without overstress of the connections. The proportioning of main members joined by such connections shall be predicated upon no greater degree of end restraint than the minimum known to be effected by the respective connections.

Types 2 and 3 construction may necessitate some non-elastic but self-limiting deformation of a structural steel part, but under forces which do not overstress the connections.

APPENDIX B

ARC AND GAS WELDING SYMBOLS

ARC AND GAS WELDING SYMBOLS										
TYPE OF WELD								FIELD WELD	WELD ALL AROUND	FLUSH
BEAD	FILLET	GROOVE					PLUG & SLOT			
		SQUARE	V	BEVEL	U	J				
LOCATION OF WELDS										
ARROW (OR NEAR) SIDE OF JOINT			OTHER (OR FAR) SIDE OF JOINT			BOTH SIDES OF JOINT				
1. THE SIDE OF THE JOINT TO WHICH THE ARROW POINTS IS THE ARROW (OR NEAR) SIDE. 2. BOTH-SIDES WELDS OF SAME TYPE ARE OF SAME SIZE UNLESS OTHERWISE SHOWN. 3. SYMBOLS APPLY BETWEEN ABRUPT CHANGES IN DIRECTION OF JOINT OR AS DIMENSIONED (EXCEPT WHERE ALL AROUND SYMBOL IS USED). 4. ALL WELDS ARE CONTINUOUS AND OF USER'S STANDARD PROPORTIONS UNLESS OTHERWISE SHOWN. 5. TAIL OF ARROW USED FOR SPECIFICATION REFERENCE (TAIL MAY BE OMITTED WHEN REFERENCE NOT USED). 6. DIMENSIONS OF WELD SIZES, INCREMENT LENGTHS AND SPACINGS ARE IN INCHES.										

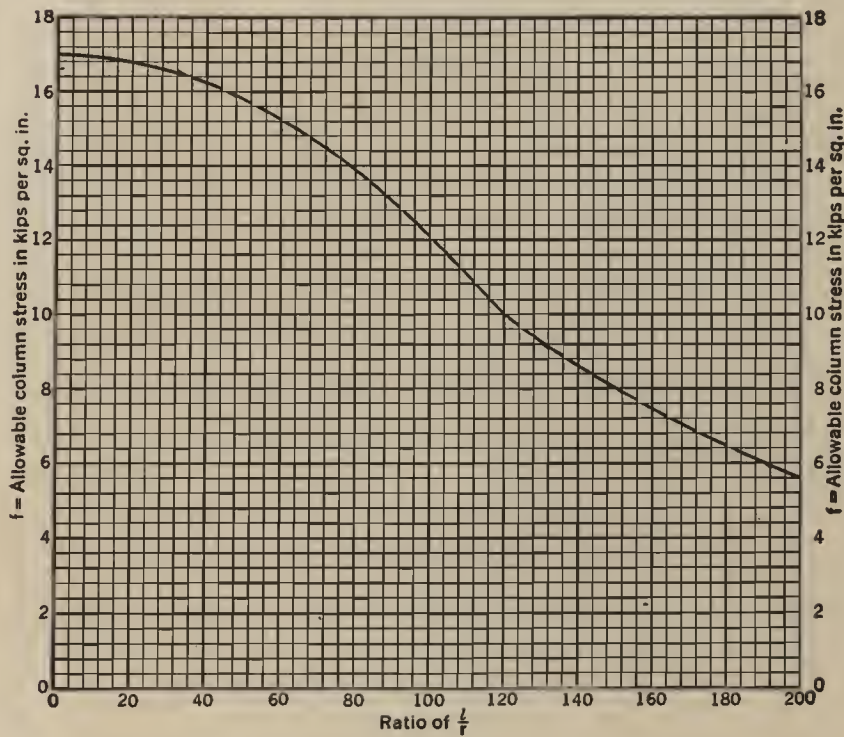
LEGEND FOR USE ON DRAWINGS SPECIFYING ARC OR GAS WELDING

The above symbols are recommended by American Welding Society for incorporation on drawings specifying fusion welding. For more detailed instruction in the use of these symbols refer to "Welding Symbols and Instructions for Their Use" published by the American Welding Society.

If the welding on the hidden face is not different from that on the visible face, the fact that there are two members must be covered by the drawing and the bill of material.

APPENDIX C

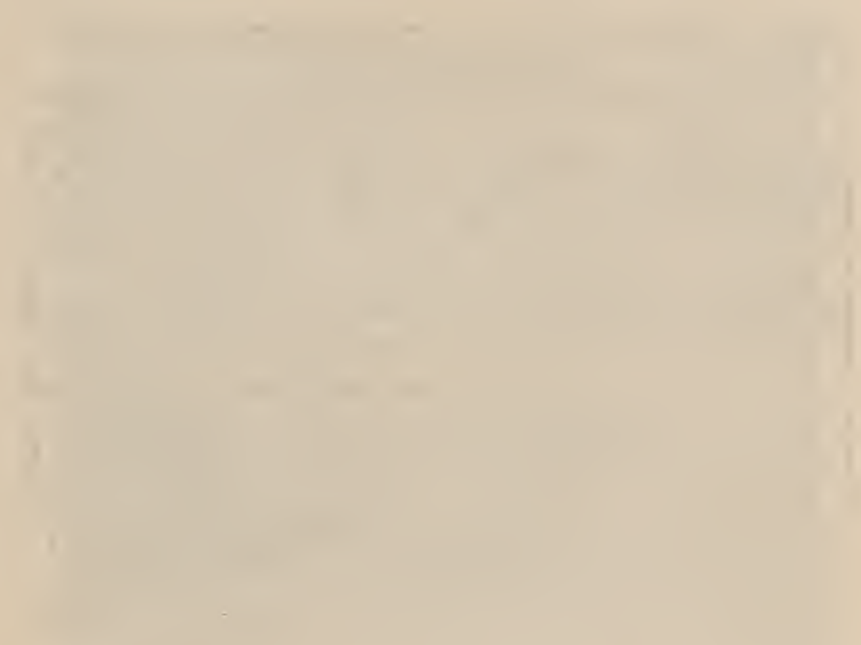
ALLOWABLE WORKING STRESS FOR AXIALLY
LOADED COLUMNS



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